IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Toru TSUKADA, et al.

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For: FEED SCREW DEVICE

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below;

That I am knowledgeable in the English language and in the Japanese language and believe the attached English translation to be a true and complete translation of the certified copy of Japanese Patent Application No. Hei. 8-155545 filed in the U.S. Patent and Trademark Office on June 17, 1996.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false

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[List of Attached Documents]

[Article]	Specification	1 copy
[Article]	Drawings	1 copy
[Article]	Abstract of the Description	1 copy

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[Title of Invention] FEED SCREW DEVICE

[Claims]

[Claim 1]

A feed screw device comprising a screw axis, a nut member threadably engaging an outer periphery of the screw axis, and a lubricant supply device being fixed to the nut member, coming in contact with the outer peripheral surface of the screw axis, and having a predetermined elastic force, wherein at least the portion of the lubricant supply device facing the screw axis is rubber or synthetic resin containing a lubricant, wherein a notch is made in the outer periphery of the lubricant supply device, and wherein an expansion member fitted at least with the notch pressed in the circumferential direction of the lubricant supply device is inserted into the notch.

[Detailed Description of the Invention]

【0001】

[Technical Field to which the Invention Belongs]

This invention relates to a feed screw device of a ball screw, square thread, etc. Particularly, this invention relates to a feed screw device having a feature in lubricant supply.

【0002】

[Prior Art]

A conventional ball screw, a kind of feed screw device, is described in Japanese Utility Model Laid-Open No. Hei 6-47762, etc., for example.

【0003】

This kind of ball screw comprises a spiral thread groove 50a made in the outer peripheral surface of a screw axis 51 threadably engaging a spiral thread groove 51a made in the inner peripheral surface of a nut member 51 via a plurality of balls 52, as shown in Figure 12, for converting relative rotation of the screw axis 50 to the nut member 51 into relative displacement in an axial direction of the nut member 51 via the balls 52.

【0004】

An annular recess 53 is formed in both end parts of the inner diameter face of the nut member 51 (in Figure 12, only the right end is shown), and a sealing member 54 is mounted on the recess 53.

【0005】

The sealing member 54 is formed of plastic containing a lubricant like a ring and a projection 54a that can be fitted into the thread groove 50a of the screw axis 50 projects from the inner peripheral surface of the sealing member.

【0006】

A ring-like garter spring 55 is inserted in the circumferential direction between the outer peripheral surface

of the sealing member 54 and the recess 53 of the nut member 51. The garter spring 55 clamps down all the outer peripheral surface of the sealing member 54 toward the outer peripheral surface of the screw axis 50, namely, the sealing member 54 in the inner diameter direction.

【0007】

Further, a tapped hole 56 diametrically cut through is made in the position of the recess 53 in the nut member 51 and a set screw 57 is fitted into the tapped hole 56, thereby fixing the sealing member 54 to the nut member 51.

【0008】

The garter spring 55 sets the gap between the inner peripheral surface of the sealing member 54 and the outer peripheral surface of the screw axis 50 to zero or less for preventing the lubricant filled in the ball screw from leaking to the outside and a foreign material from entering the ball screw from the outside.

【0009】

Further, the lubricant exuding from the sealing member 54 decreases frictional resistance of the slide portion between the inner peripheral surface of the sealing member 54 and the outer peripheral surface of the screw axis 50, namely, slide torque and at the same time, is supplied to the thread groove 50a of the screw axis 50, the balls 52, and the thread groove 51a of the nut member 51.

【0010】

[Problems that the Invention is to Solve]

However, for the conventional feed screw device of the structure as described above, the garter spring 55 needs to be inserted between the outer periphery of the sealing member 54 and the recess 53 of the nut member 51 so that a dimension error of the sealing member 54 is absorbed and that the inner peripheral surface of the sealing member 54 comes in sliding contact with the outer peripheral surface of the screw axis 50; it is feared that the outer diameter of the feed screw device may grow as large as the garter spring.

【0011】

In the conventional structure, the sealing member 54 is pressed diametrically, whereby it is abutted against the outer peripheral surface of the screw axis 50, thus the spring needs to be disposed on all the outer periphery of the sealing member 54 in the circumferential direction.

【0012】

The inner diameter portion on the opposite side (portion not pressed by the garter spring) to the side pressed by the garter spring 55 of the sealing member 54 floats up with respect to the outer peripheral surface of the screw axis and it is feared that a sufficient lubricant will not be supplied from the portion.

【0013】

Some conventional feed screw devices comprise a spring inserted between the tip of the set screw 57 and the sealing member 54 in place of the garter spring 55. However, the lubricant supply section is also pressed only diametrically, thus it is feared that the inner peripheral surface of the sealing member 54 may be placed out of contact with the outer peripheral surface of the screw axis 50 or that the portion pressed by the set screw in sliding contact with the screw axis may be worn on one side in portions shifted 90 degrees from the placement position of the set screw 57, etc., for example.

【0014】

It is therefore an object of the invention to provide a feed screw device for enabling a lubricant-containing member to come in uniform contact with an outer peripheral surface of a screw axis without enlarging the outer diameter of the feed screw device and in a simple structure.

【0015】

[Means for Solving the Problems]

According to the invention, there is provided a feed screw device comprising a screw axis, a nut member threadably engaging an outer periphery of the screw axis, and a lubricant supply device being fixed to the nut member, coming in contact with the outer peripheral surface of the screw axis, and having a predetermined elastic force, wherein at least the portion

of the lubricant supply device facing the screw axis is rubber or synthetic resin containing a lubricant, wherein a notch is made in the outer periphery of the lubricant supply device, and wherein an expansion member fitted at least with the notch pressed in the circumferential direction of the lubricant supply device is inserted into the notch.

【0016】

In the structure, when the expansion member is inserted into the notch of the lubricant supply device, it causes the notch to push and widen at least the outer periphery of the lubricant supply device in the circumferential direction.

【0017】

Thus, a compression force along the circumferential direction acts on the inside of the outer periphery of the lubricant supply device, at least deforming all the inner peripheral surface in the inner diameter direction. Resultantly, the inner diameter of the lubricant supply device is reduced for absorbing a dimension error of the lubricant supply device, and the inner peripheral surface of the lubricant supply device comes in contact with the outer peripheral surface of the screw member.

【0018】

As the feed screw device is driven, a lubricant contained in the lubricant supply device exudes gradually over time, whereby slide resistance between the outer peripheral surface

of the screw member and the inner peripheral surface of the lubricant supply device is decreased and as the feed screw device is driven, a lubricant is supplied to the outer peripheral surface of the screw member.

【0019】

The expansion member is inserted only into a part of the lubricant supply device (notch), namely, all the inner peripheral surface of the lubricant supply device can be brought into contact with the outer peripheral surface of the screw axis without installation on all the outer peripheral surface of the lubricant supply device.

【0020】

If the expansion member is formed with a projection projecting from a part of the outer peripheral surface of the lubricant supply device, the projection is fitted into the nut member, etc., whereby the expansion member also serves prevention of rotation of the lubricant supply device.

【0021】

For example, a lubricant-containing polymer member can be adopted as the lubricant supply device containing a lubricant according to the invention.

For example, the product manufactured in the following manner can be used as the lubricant-containing polymer member: Any of paraffin family hydrocarbon oil such as poly α-olefin oil, naphthene family hydrocarbon oil, mineral oil, ether oil

such as dialkyl diphenyl ether oil, or ester oil such as phthalate ester or trimellitate ester is mixed as a lubricant with a polymer selected from the group consisting of polyolefin family polymers basically having the same chemical structure such as polyethylene, polypropylene, polybutylene, and polymethylpentane and the mixture is fused, then poured into a predetermined mold and cooled and fixed under pressure.

【0022】

Various additive agents such as an antioxidant, a rust preventive, a wear inhibitor, a defoaming agent, and an extreme pressure agent may be previously added to the mixture.

The percentage composition of the lubricant-containing polymer member may be set to 20%-80% by weight of polyolefin family polymer and 80%-20% by weight of lubricant with respect to all weight, because if the polyolefin family polymer is less than 20% by weight, hardness, strength, etc., required as the lubricant supply device cannot be provided and if the polyolefin family polymer exceeds 80% by weight (the lubricant is less than 20% by weight), lubricant supply lessens and the slide torque reduction and lubricant supply effects decrease.

【0023】

The above-mentioned polymers have the same basic structure and differ in average molecular weight, covering the range of 1×10^3 to 5×10^6. Among the polymers, those of comparatively low molecular weight ranging from 1×10^3

to 1 X 10^6 and those of ultra high molecular weight ranging from 1 X 10^6 to 5 X 10^6 are used solely or mixed as required.

【0024】

To improve the mechanical strength of the lubricant supply device, the following thermoplastic resin and thermosetting resin may be added to the polyolefin family polymer:

【0025】

Resin such as polyamide, polycarbonate, polybutylene terephthalate, polyphenylene sulfide, polyether sulfone, polyether ether ketone, polyamide imide, polystyrene, or ABS resin can be used as the thermoplastic resin.

【0026】

Resin such as unsaturated polyester resin, urea resin, melamine resin, phenol resin, polyimide resin, or epoxy resin can be used as the thermosetting resin.

【0027】

The resins may be used solely or mixed.

Further, to disperse the polyolefin family polymer and any other resin in a more uniform state, a proper compatibilization agent may be added as required.

【0028】

In addition to the polyolefin family polymer and lubricant combinations as described above, polyurethane rubber cured in a grease-containing condition can also be used as

the lubricant-containing polymer, as described below in detail:

【0029】

Polyurethane rubber is a compound produced by reaction of polyisocyanate with an activated hydrogen compound.

Tolylene diisocyanate (TDI), hexamethylene diisocyanate (MDI), prepolymer (MW1000-MW2000) produced by reaction of TDI and MDI with an activated hydrogen compound, such as castor oil, or the like can be used as polyisocyanate.

【0030】

A long chain activated hydrogen compound such as hydrocarbon of polybutadiene, etc., polyether of polyoxypropylene, etc., caster oil or caster oil family polyol, polyester, or polycarbonate, a polyhydroxy compound such as water or ethylene glycol, or a short chain activated hydrogen compound such as polyhydroxy compound, amino alcohol, or polyamino compound can be used as the activated hydrogen compound.

【0031】

Normal grease such as mineral oil or lithium soap grease can be used as the grease.

In this case, preferably the percentage composition of the lubricant-containing polymer member may be set to 80%-40% by weight of polyurethane rubber and 20%-60% by weight of grease with respect to all weight. If polyurethane rubber is less than 40% by weight, necessary hardness, strength, etc., cannot

be provided. If polyurethane rubber exceeds 80% by weight (grease is less than 20% by weight), lubricant supply lessens and the slide torque reduction effect decreases.

【0032】

[Embodiments]

Referring now to the accompanying drawings, there are shown preferred embodiments of the invention. In the embodiments, feed screw devices will be discussed by taking ball screws as examples. Of course, the description to follow goes for other feed screw devices such as square threads.

【0033】

Figure 1 is an exploded perspective view to show the main part of a ball screw according to a first embodiment of the invention and Figure 2 is a sectional view of the main part.

First, a general configuration of the first embodiment will be discussed. The ball screw comprises a nut member 2 threadably engaged into a screw axis 1 having a spiral thread groove 1a on an outer peripheral surface via a large number of balls 3. The nut member 2 is formed in an inner peripheral surface with a thread groove 2a corresponding to the thread groove 1a of the screw axis 1 and has a ball circulation passage (not shown) for guiding and circulating the balls 3 rolling in both the thread grooves 1a and 2a in a thick belly portion.

【0034】

A recess 4 for attaching a lubricant supply device is formed in both end faces of the inner diameter side of the nut member 2 coaxially with the nut member 2. Two tapped holes 5 are made in each of both the end faces of the nut member 2 with the axes parallel with the axis of the nut member 2. A lubricant supply device 6 is fitted into the recess 4 of the nut member 2 coaxially.

【0035】

The lubricant supply device 6 is a ring-like member having an outer diameter that can be fitted into the recess 4, as shown in Figure 3; for example, it is made of a material such as rubber or synthetic resin for producing a predetermined elastic force for providing flexibility and contains a lubricant such as grease or mineral oil.

【0036】

The lubricant supply device 6 has an assembly cut part 6a at a place in a circumferential direction of the lubricant supply device 6 and is formed with notches 7 at outer peripheral positions shifted by 90 degrees from the cut part 6a in the circumferential direction, whereby the two notches 7 are formed at symmetrical positions mutually shifted 180 degrees in the circumferential direction. In the embodiment, the notches 7 are made circular in cross section extending in a thickness direction of the lubricant supply device 6.

【0037】

Further, projections 6b that can be fitted into the thread groove 1a of the screw axis 1 project in the inner diameter direction on the inner peripheral surface of the lubricant supply device 6.

Tubular members 8 are included making up an expansion member that can be fitted into the notches 7 of the lubricant supply device 6. The tubular member 8 has an external diameter slightly larger than the diameter of the notch 7 and is slightly longer than the thickness of the lubricant supply device 6.

【0038】

Further, a retaining ring 9 is included for attaching the lubricant supply device 6 to the nut member 2.

This retaining ring 9 has an inner diameter which is the same as the diameter of the nut member 2 and an inner diameter to place the retaining ring 9 out of contact with the outer peripheral surface of the screw axis 1, as shown in Figure 4. On the face of the retaining ring 9 opposed to the nut member 2, through holes 9a are made at positions corresponding to the tapped holes 5 made in the nut member 2 and recesses 9b into which the tubular members 8 can be fitted are formed at positions corresponding to the notches 7 of the lubricant supply device 6.

【0039】

First, the lubricant supply device 6 is fitted into the recess 4 and is inserted between the screw axis 1 and the

nut member 2, then the tubular members 8 are fitted into the notches 7 of the lubricant supply device 6 in parallel with the axis of the nut member 2. Alternatively, after the tubular members 8 are fitted into the notches 7, the lubricant supply device 6 is fitted into the recess 4. In the state, the ends of the tubular members 8 fitted into the notches 7 project outward.

【0040】

Successively, the projecting ends of the tubular members 8 are fitted into the recesses 9b of the retaining ring 9 and the retaining ring 9 is abutted against the end of the nut member 2, then set screws 10 inserted into the through holes 9a of the retaining ring 9 are threadably engaged into the tapped holes 5 of the nut member 2. Thus, the lubricant supply device 6 is fixed to the nut member 2.

【0041】

Here, the lubricant supply device 6 is formed only of a lubricant-containing polymer, for example. To manufacture the lubricant supply device 6, for example, a lubricant-containing polymer is fused, then injected into a predetermined metal mold, pressurized, cooled and hardened, and molded. In this case, injection molding can be executed. For example, used as the lubricant-containing polymer member is a mixture of polyethylene consisting of 20% by weight of low molecular weight polyethylene (molecular weight 1 X 10^3

to 5 X 10^5) and 10% by weight of ultra-high molecular weight polyethylene (molecular weight 1 X 10^6 to 5 X 10^6) and 70% by weight of paraffin family mineral oil as a lubricant.

【0042】

Next, the operation and effects of the ball screw will be discussed.

When the screw axis 1 makes relative rotation to the nut member 2, the balls 3 in the nut member 2 roll on a spiral space formed by the relative thread grooves 1a and 2a in the rotation direction of the screw axis 1 and circulate through a ball circulation passage (not shown). As the balls 3 roll, the nut member 2 is fed in the linear direction along the screw axis 1. The projections 6b of the lubricant supply device 6 prevent the lubricant filled in the ball screw from leaking to the outside and also prevent a foreign material such as dust from entering the ball screw from the outside; the lubricant supply device 6 also serves as a seal member.

【0043】

Since the lubricant supply device 6 has a dimension error, it is feared that a microscopic gap may be formed between the inner peripheral surface and the outer peripheral surface of the screw axis 1. In the embodiment, however, the tubular members 8 larger than the notches 7 are inserted into the notches 7, whereby the notches 7 push and widen the outer periphery of the lubricant supply device 6 in the circumferential direction,

as shown in Figure 5.

【0044】

That is, a compression force toward the circumferential direction acts on the inside of the outer periphery of the lubricant supply device 6 and causes the full inner peripheral surface to be displaced to the inner diameter side. Resultantly, even if a dimension error exists, the full inner peripheral surface of the lubricant supply device 6 comes in reliable contact with the outer peripheral surface of the screw axis 1.

【0045】

At this time, in the embodiment, the lubricant supply device 6 is not pressed diametrically for bringing the inner peripheral surface into contact with the outer peripheral surface of the screw axis 1; instead, the compression force along the circumferential direction causes the inner peripheral surface to come in contact with the outer peripheral surface of the screw axis 1, thus the notches 7 need not be made in all the peripheral surface of the lubricant supply device 6. Moreover, the tubular members 8 of expansion members are only inserted into the lubricant supply device 6, so that enlarging the diameter of the nut member 2, namely, the outer diameter of the feed screw device is not required either.

【0046】

Since the lubricant supply device 6 contains a lubricant,

the lubricant exuding gradually from the inner peripheral surface of the lubricant supply device 6 drastically reduces frictional resistance at the sliding time between the inner peripheral surface of the lubricant supply device 6 and the outer peripheral surface of the screw axis 1, so that slide torque lessens, preventing disturbance of drive of the ball screw.

【0047】

Further, when the ball screw is driven, a lubricant exudes gradually from the inner peripheral surface of the lubricant supply device 6 with relative rotation of the screw axis 1, is supplied to the thread groove 1a of the screw axis 1, and uniformly covers the balls 3 rolling in the thread groove 1a and the thread groove 2a of the nut member 2 for stable lubrication over a long term.

【0048】

Therefore, if a lubricant is not supplied to the inside of the nut member 2 from the outside, the ball screw can continue good running for a long time at low torque. Since a lubricant need not be supplied to the inside of the nut member 2 from the outside, the ball screw can be used as effective lubrication means in a system that can use only an extremely small amount of lubricant, such as a semiconductor manufacturing system.

【0049】

Further, as described above, the tubular members 8 are inserted into the notches 7, whereby a compression force

toward the circumferential direction acts on the inside of the lubricant supply device 6, also producing the effect of bringing the opposed faces of the cut parts 6a made in the lubricant supply device 6 into contact with each other or lessening the gap therebetween.

【0050】

The ends of the tubular members 8 for pressing the inner peripheral surface of the lubricant supply device 6 against the outer periphery of the screw axis 1 are fitted only into the recesses 9b of the retaining ring 9, whereby when the ball screw is driven, rotation of the lubricant supply device 6 can be prevented. This means that the tubular members 8 of expansion members also have a role in stopping rotation of the lubricant supply device 6.

【0051】

Next, a second embodiment of the invention will be discussed. Members identical with or similar to those previously described in the first embodiment are denoted by the same reference numerals.

The basic configuration of a ball screw of the second embodiment is similar to that of the first embodiment, as shown in Figure 6.

【0052】

That is, as shown in Figure 7, a lubricant supply device 6 is formed in an outer peripheral surface with three notches

shifted by 90 degrees in the circumferential direction and is not formed on an inner peripheral surface with projections 6b fitted into thread groove 1a of screw axis 1.

【0053】

Expansion members 12 inserted into the notches 7 are made of spring members each having a slit 12a along the axial direction, as shown in Figure 8, for easy assembling of the expansion members 12.

【0054】

A retaining ring 9 has an outer diameter that can be fitted into a recess 4 made in a nut member 2 and has tapped holes 9c, each with an axis directed diametrically, made in the peripheral surface in place of through holes 9a, as shown in Figure 9. Mounting holes 13, each with an axis directed diametrically, corresponding to the tapped holes are also made in the nut member 2. In Figure 6, numeral 17 denotes a set screw mounted in the tapped hole 9c and the mounting hole 13.

【0055】

Other components are similar to those of the first embodiment.

The second embodiment has the function and effects similar to those of the first embodiment.

The lubricant supply device 6 is not formed on the inner peripheral surface with projections 6b that can be fitted into the thread groove 1a of the screw axis 1. However, the

inner diameter of the lubricant supply device 6 is shrunk by the action of the expansion members for pressing the inner peripheral surface of the lubricant supply device 6 against the outer peripheral surface of the screw axis 1, thereby making contact.

【0056】

Next, a third embodiment of the invention will be discussed. Members identical with or similar to those previously described in the first embodiment are denoted by the same reference numerals.

The basic configuration of a ball screw of the third embodiment is similar to that of the first embodiment, as shown in Figures 10 and 11.

【0057】

However, a lubricant supply device 6 is abutted against the end face of a nut member 2 coaxially without forming the nut member 2 with a recess into which the lubricant supply device 6 is fitted.

【0058】

Tapped holes 15 are made at positions of the end face of the nut member 2 corresponding to the positions of notches 7 made in the lubricant supply device 6.

A retaining ring 9 is molded like a cap that can store the lubricant supply device 6. Small-diameter tapped holes 16 directed toward the outside from the bottom faces of recesses

9b into which tubular members 8 are fitted are made in place of through holes 9a.

【0059】

The tips of set screws 10 penetrating the tapped holes 16, the recesses 9b, and the tubular members 8 coaxially are threadably engaged into the tapped holes 15 of the nut member 2 for fixing the lubricant supply device 6.

Thus, without making recesses 4 in the nut member 2, the set screws 10 for fixing the lubricant supply device 6 can be laid out at the same positions as the placement positions of the tubular members 8 of expansion members.

【0060】

At least the portion of the lubricant supply device 6 coming in contact with the outer peripheral surface of a screw axis 1, namely, only the inner peripheral surface may be made of a member containing a lubricant.

The lubricant supply device 6 may have only the inner diameter side softened. In doing so, the hardness for holding the shape required as the lubricant supply device 6 can be provided on the outer peripheral surface side and the displacement amount in the inner diameter direction on the inner peripheral side produced by a compression force along the circumferential direction can be set large and press pressure against the outer peripheral surface of the screw axis 1 can be set small.

【0061】

In the embodiments, two or three notches 7 are provided. However, one notch 7 or four or more notches 7 may be made. The notches 7 need not be of the same shape.

【0062】

The shape is not limited to circular cross section and may be angular cross section; the axis of the notch 7 need not necessarily be set in parallel with the axis of the nut member 2.

In the embodiments, the notches 7 are opened to the outer periphery of the lubricant supply device 6, but may be formed like a hole with the outer periphery side closed. However, the notch opened to the outer periphery produces a larger effect.

【0063】

The hollow tubular members are adopted for the expansion members as an example, but the expansion members are not limited to them; they may be like a circular cylinder and the cross section is not limited to being circular.

【0064】

Further, in the embodiments, the ends of the expansion members are projected to the side of the retaining ring 9, but may be projected to the side of the nut member 2 and the corresponding recesses may be made on the side of the number member 2. A portion projecting toward the outer peripheral direction of the lubricant supply device 6 may be made on the

outer periphery of the expansion member for use as a rotation stopper.

【0065】

In the embodiments, the lubricant supply device 6 also serves as a seal member, but a separate seal member may be provided.

【0066】

[Effect of the Invention]

As we have discussed, when the feed screw device of the invention is driven, a lubricant in the lubricant supply device exudes gradually with rotation of the screw axis and is automatically supplied to the feed screw device. Resultantly, if a lubricant is not supplied from the outside, the feed screw device can continue good running for a long time at low torque.

【0067】

Particularly, since a lubricant need not be supplied from the outside, the feed screw device can be used as effective lubrication means in a system that can use only an extremely small amount of lubricant, such as a semiconductor manufacturing system.

【0068】

Moreover, in the feed screw device of the invention, the inner peripheral surface of the lubricant supply device can be brought into reliable contact with the outer peripheral surface of the screw axis by simple means and the outer diameter

of the feed screw device is not made large.

[Brief Description of the Drawings]

[Fig. 1]

Figure 1 is an exploded perspective view to show the main part of a ball screw according to a first embodiment of the invention.

[Fig. 2]

Figure 2 is a sectional view to show the main part of a ball screw according to the first embodiment of the invention.

[Fig. 3]

Figure 3 is views to show a lubricant supply device according to the first embodiment of the invention; 3 (a) and (b) are a sectional view and a front view of the lubricant supply device respectively.

[Fig. 4]

Figure 4 is views to show a retaining ring according to the first embodiment of the invention; 4 (a) and (b) are a side view of the retaining ring and a front view from the outside of the retaining ring.

[Fig. 5]

Figure 5 is an illustration to explain the effects of notches and expansion members according to the first embodiment of the invention; 5 (a) shows a state before the expansion members are inserted and 5 (b) show a state after the expansion members are inserted.

[Fig. 6]

Figure 6 is a sectional view to show the main part of a ball screw according to a second embodiment of the invention.

[Fig. 7]

Figure 7 is views to show a lubricant supply device according to the second embodiment of the invention; 7 (a) and (b) are a sectional view and a front view of the lubricant supply device respectively.

[Fig. 8]

Figure 8 is views to show an expansion member according to the second embodiment of the invention; 8 (a) and (b) are a side view and a front view of the expansion member respectively.

[Fig. 9]

Figure 9 is views to show a retaining ring according to the second embodiment of the invention; 9 (a) and (b) are a side view of the retaining ring and a front view from the outside of the retaining ring.

[Fig. 10]

Figure 10 is an exploded perspective view to show the main part of a ball screw according to a third embodiment of the invention.

[Fig. 11]

Figure 11 is a fragmentary sectional view to show the main part of the ball screw according to the third embodiment of the invention.

[Fig. 12]

Figure 12 is a fragmentary sectional view to show the main part of a conventional ball screw.

[Description of Reference Numerals and Signs]

1 screw axis

1a thread groove

2 nut member

2a thread groove

3 ball

4 recess

5 tapped hole

6 lubricant supply device

7 notch

8 tubular member (expansion member)

9 retaining ring

9a through hole

9b recess

10 set screw

12 expansion member

[Name of Document] Abstract of the Disclosure

[Abstract]

[Object] To provide a feed screw device for enabling a lubricant-containing member to come in reliable contact with an outer peripheral surface of a screw axis without enlarging the outer diameter of the feed screw device and in a simple structure.

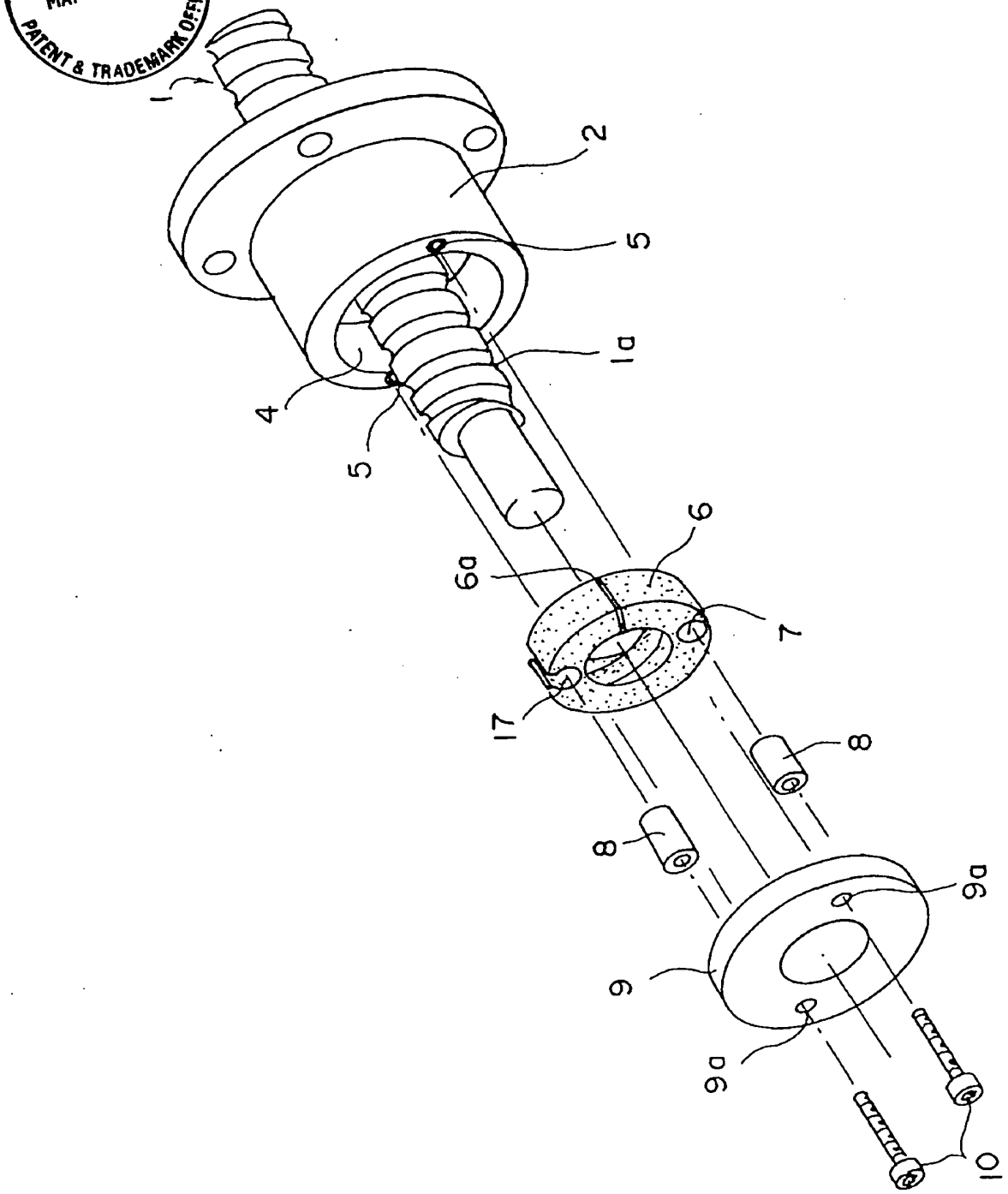
[Solving Means] A ring-like lubricant supply device 6 is fitted into a recess 4 of a nut member 2. The lubricant supply device 6 contains a lubricant and is formed in an outer peripheral surface with notches 7. Tubular members 8 each having an outer diameter larger than the diameter of the notch 7 are inserted into the notches, pushing and widening the notches 7 in a circumferential direction. One end of the tubular member 8 is fitted into a recess 9b of a retaining ring 9 and the retaining ring 9 is fixed to a nut member 2.

[Selected Drawing]

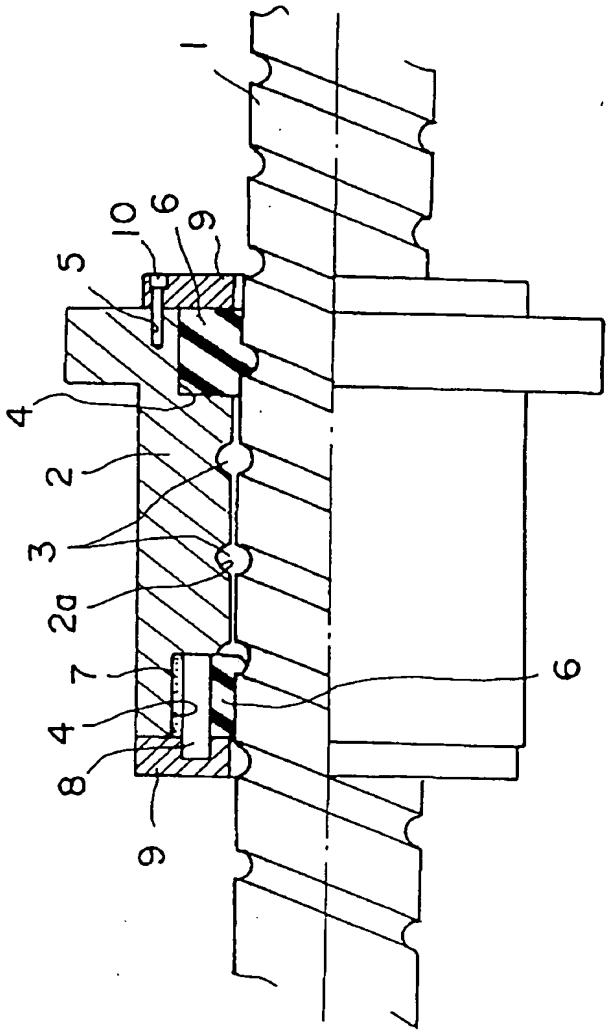
Fig. 1

【書類名】 図面 Drawing

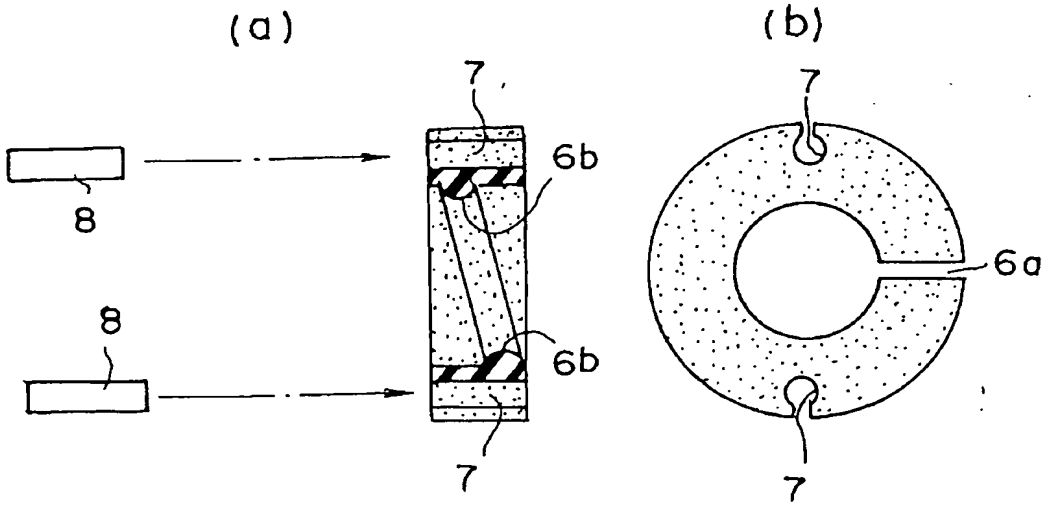
【図1】 Fig 1



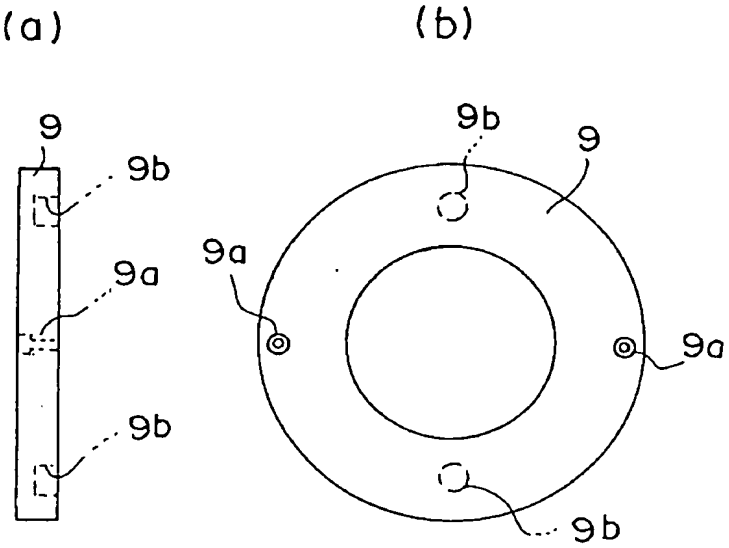
【図2】 Fig 2



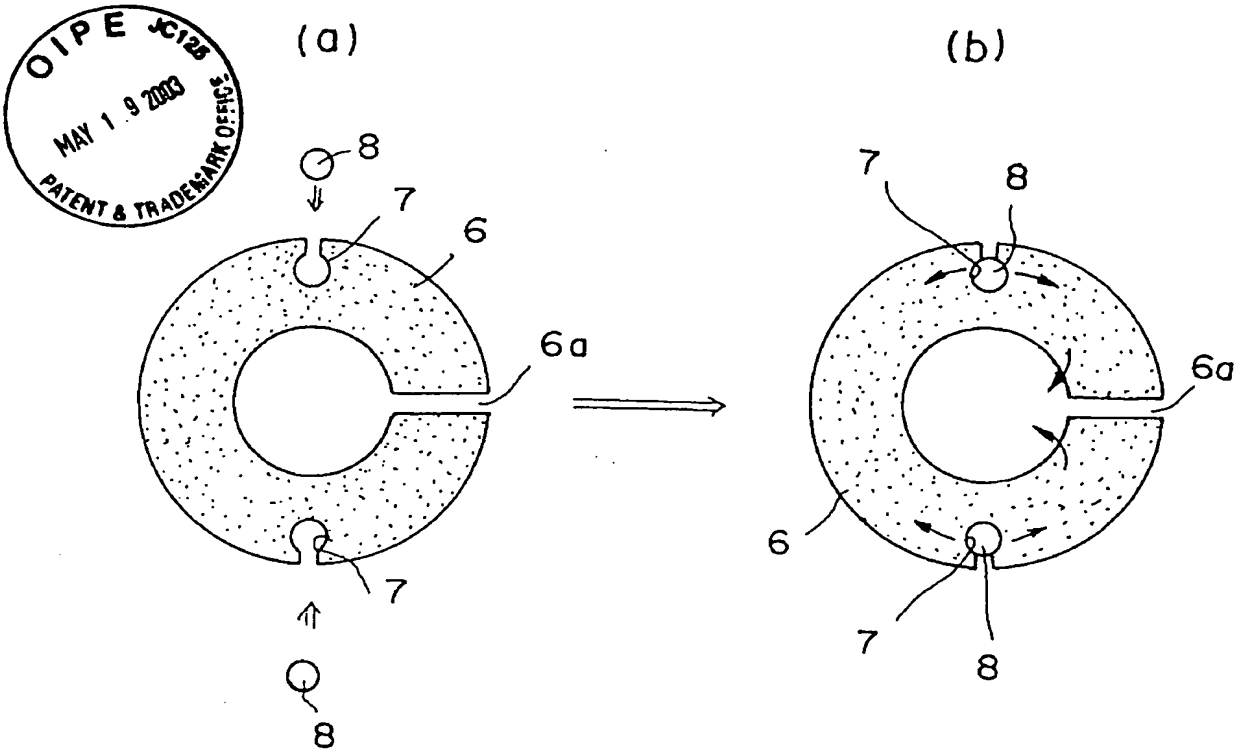
【図3】 Fig 3



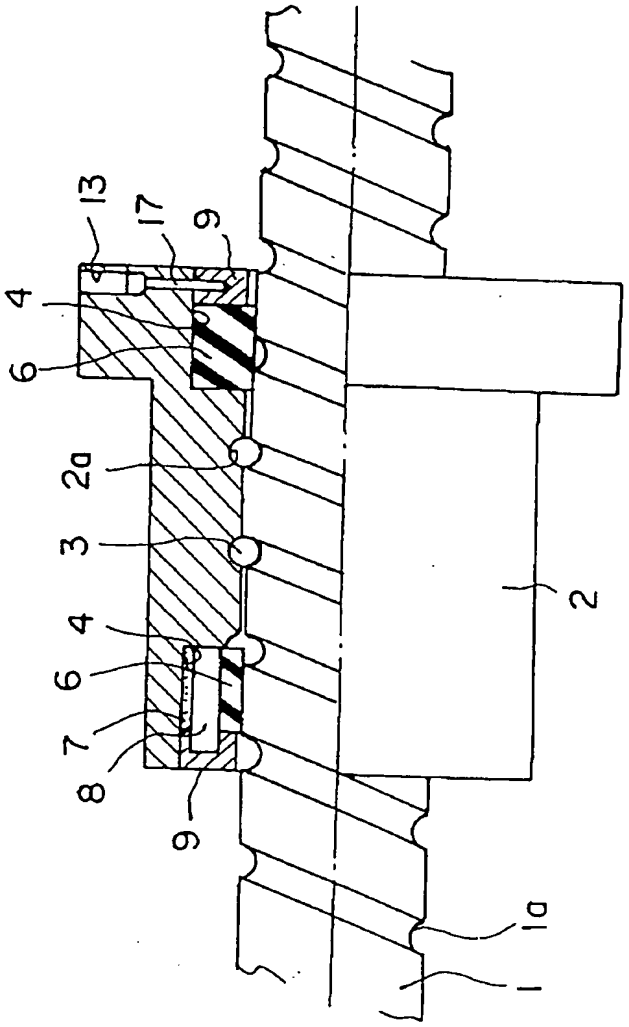
【図4】 Fig 4



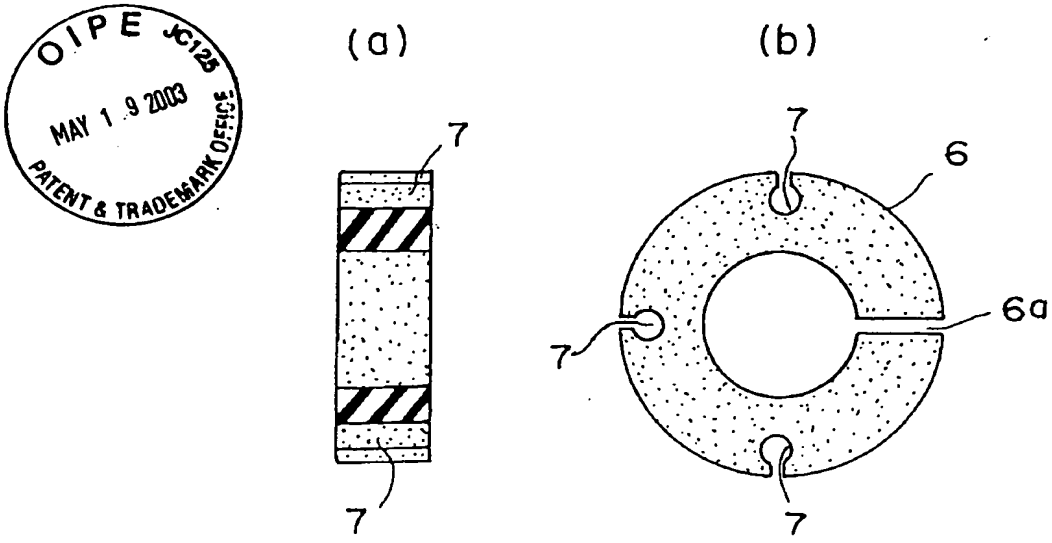
【図5】 Fig 5



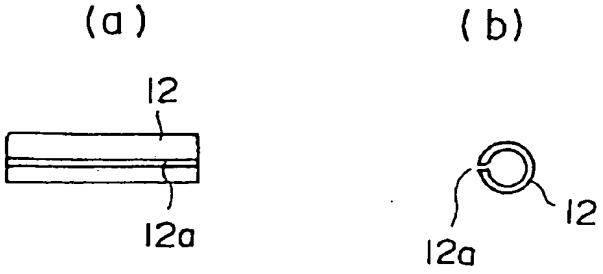
【図6】 Fig 6



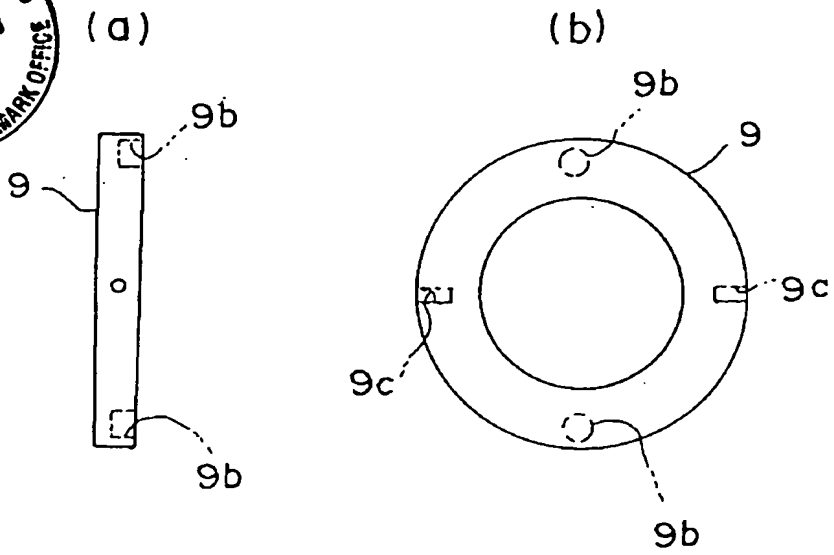
【図7】 Fig 7



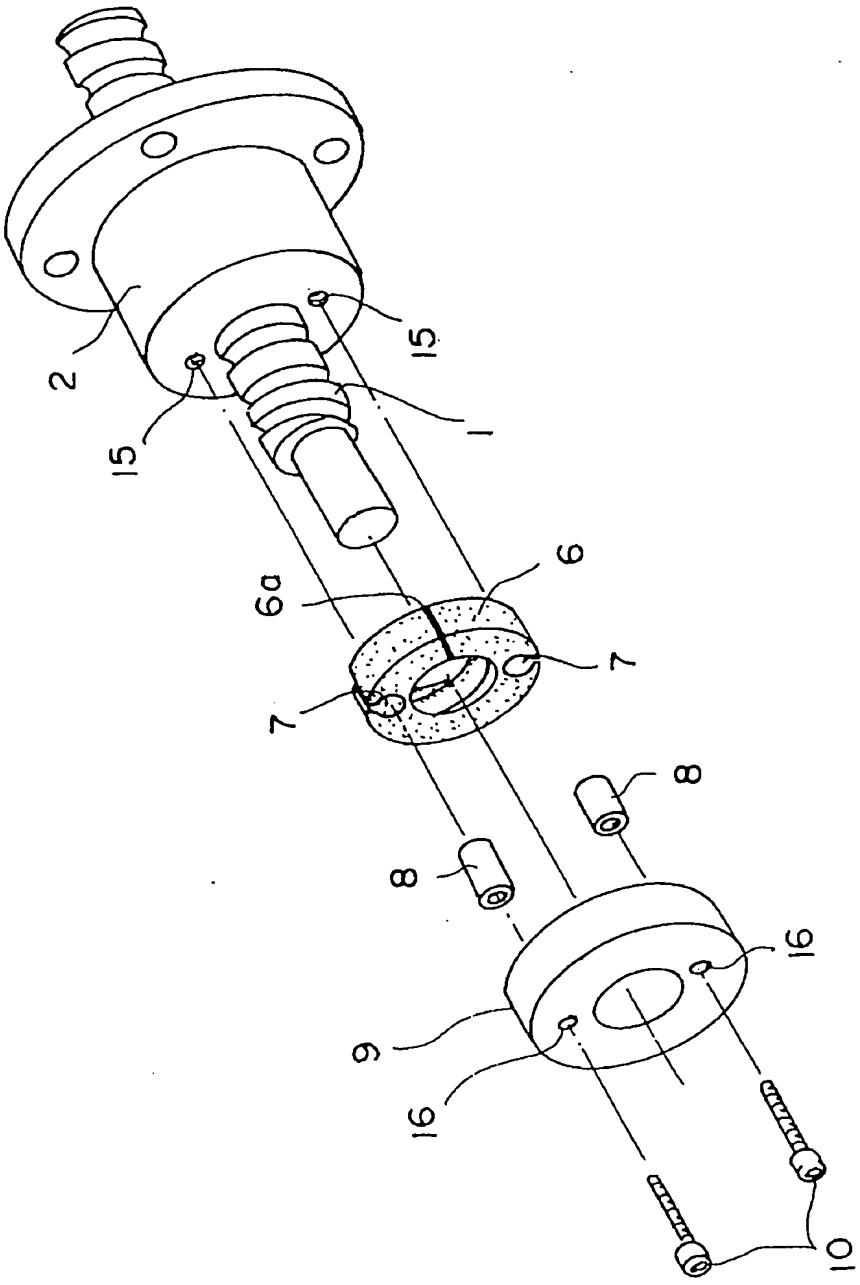
【図8】 Fig 8



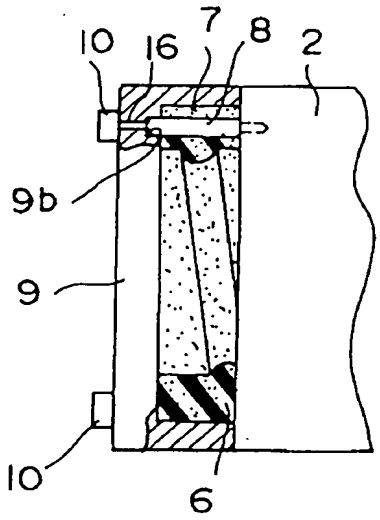
【図9】 Fig 9



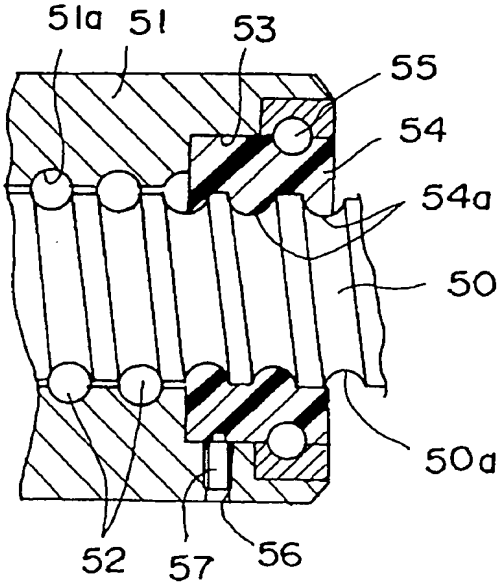
【図１０】 Fig 10



【図１１】 Fig 11



【図１２】 Fig 12



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